JC10 Rec'd PCT/PTO 25 FEB 2002

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FORM PTO-1390 (REV. 9-2001) U S DEPARTMENT OF COMMERCE PATENT AND TRADEMARK OFFICE

TRANSMITTAL LETTER TO THE UNITED STATES DESIGNATED/ELECTED OFFICE (DO/EO/US) CONCERNING A FILING UNDER 35 U.S.C. 371

ATTORNEY 'S DOCKET NUMBER
SMB-PT042 (PC 00 396 B US)

U S. APPLICATION NO (If known, see 37 CFR 1.5
10/069473

INTERNATIONAL APPLICATION NO.	INTERNATIONAL FILING DATE	PRIORITY DATE CLAIMED
PCT/EP00/06727	14 July 2000	26 August 1999

TITLE OF INVENTION MEMBRANE PUMP

APPLICANT(S) FOR DO/EO/US HAUSER et al.

Applicant herewith submits to the United States Designated/Elected Office (DO/EO/US) the following items and other information:

1. [X] This is a **FIRST** submission of items concerning a filing under 35 U.S.C. 371.
2. [ ] This is a **SECOND** or **SUBSEQUENT** submission of items concerning a filing under 35 U.S.C. 371.
3. [ ] This is an express request to begin national examination procedures (35 U.S.C. 371(f)). The submission must include items (5), (6), (9) and (21) indicated below.
4. [ ] The US has been elected by the expiration of 19 months from the priority date (Article 31).
5. [X] A copy of the International Application as filed (35 U.S.C. 371(c)(2))
   - a. [ ] is attached hereto (required only if not communicated by the International Bureau).
   - b. [X] has been communicated by the International Bureau.
   - c. [ ] is not required, as the application was filed in the United States Receiving Office (RO/US).
6. [ ] An English language translation of the International Application as filed (35 U.S.C. 371(c)(2)).
   - a. [ ] is attached hereto.
   - b. [ ] has been previously submitted under 35 U.S.C. 154(d)(4).
7. [X] Amendments to the claims of the International Aplication under PCT Article 19 (35 U.S.C. 371(c)(3))
   - a. [ ] are attached hereto (required only if not communicated by the International Bureau).
   - b. [ ] have been communicated by the International Bureau.
   - c. [ ] have not been made; however, the time limit for making such amendments has NOT expired.
   - d. [X] have not been made and will not be made.
8. [ ] An English language translation of the amendments to the claims under PCT Article 19 (35 U.S.C. 371 (c)(3)).
9. [X] An oath or declaration of the inventor(s) (35 U.S.C. 371(c)(4)).
10. [ ] An English lanugage translation of the annexes of the International Preliminary Examination Report under PCT Article 36 (35 U.S.C. 371(c)(5)).

Items 11 to 20 below concern document(s) or information included:

11. [ ] An Information Disclosure Statement under 37 CFR 1.97 and 1.98.
12. [X] An assignment document for recording. A separate cover sheet in compliance with 37 CFR 3.28 and 3.31 is included.
13. [X] A FIRST preliminary amendment.
14. [ ] A SECOND or SUBSEQUENT preliminary amendment.
15. [ ] A substitute specification.
16. [ ] A change of power of attorney and/or address letter.
17. [ ] A computer-readable form of the sequence listing in accordance with PCT Rule 13ter.2 and 35 U.S.C. 1.821 - 1.825.
18. [ ] A second copy of the published international application under 35 U.S.C. 154(d)(4).
19. [ ] A second copy of the English language translation of the international application under 35 U.S.C. 154(d)(4).
20. [X] Other items or information:

PCT/EP00/06727 Cover Sheet; Drawings;
International Preliminary Examination Report with attached replacement pages (in German); and Application Data Sheet.

JC19 Rec'd PCT/PTO 25 FEB 2002

U.S. APPLICATION NO. (If known, see 37 CFR 1.5) 10/069473	INTERNATIONAL APPLICATION NO PCT/EP00/06727	ATTORNEY'S DOCKET NUMBER SMB-PT042 (PC 00 396 B US

				CALCULATIONS	PTO USE ONLY
21. [X] The following fees are submitted: **BASIC NATIONAL FEE (37 CFR 1.492 (a) (1) - (5)):** Neither international preliminary examination fee (37 CFR 1.482) nor international search fee (37 CFR 1.445(a)(2)) paid to USPTO and International Search Report not prepared by the EPO or JPO .... **$1040.00** International preliminary examination fee (37 CFR 1.482) not paid to USPTO but International Search Report prepared by the EPO or JPO .... **$890.00** International preliminary examination fee (37 CFR 1.482) not paid to USPTO but international search fee (37 CFR 1.445(a)(2)) paid to USPTO .... **$740.00** International preliminary examination fee (37 CFR 1.482) paid to USPTO but all claims did not satisfy provisions of PCT Article 33(1)-(4) .... **$710.00** International preliminary examination fee (37 CFR 1.482) paid to USPTO and all claims satisfied provisions of PCT Article 33(1)-(4) **$100.00**					
ENTER APPROPRIATE BASIC FEE AMOUNT =				$ 890	
Surcharge of **$130.00** for furnishing the oath or declaration later than [ ] 20 [ ] 30 months from the earliest claimed priority date (37 CFR 1.492(e)).				$	
CLAIMS	NUMBER FILED	NUMBER EXTRA	RATE	$	
Total claims	1 - 20 =	0	x **$18.00**	$ 0	
Independent claims	1 - 3 =	0	x **$84.00**	$ 0	
MULTIPLE DEPENDENT CLAIM(S) (if applicable)			+ **$280.00**	$ -	
TOTAL OF ABOVE CALCULATIONS =				$ 890	
[ ] Applicant claims small entity status. See 37 CFR 1.27. The fees indicated above are reduced by 1/2. +				$	
SUBTOTAL =				$ 890	
Processing fee of **$130.00** for furnishing the English translation later than [ ] 20 [ ] 30 months from the earliest claimed priority date (37 CFR 1.492(f)).				$ -	
TOTAL NATIONAL FEE =				$ 890	
Fee for recording the enclosed assignment (37 CFR 1.21(h)). The assignment must be accompanied by an appropriate cover sheet (37 CFR 3.28, 3.31). **$40.00** per property +				$ 40	
TOTAL FEES ENCLOSED =				$ 930	
				Amount to be refunded:	$
				charged:	$

a. [X] A check in the amount of $ 930 to cover the above fees is enclosed.

b. [ ] Please charge my Deposit Account No. ______________ in the amount of $ ___________ to cover the above fees. A duplicate copy of this sheet is enclosed.

c. [X] The Commissioner is hereby authorized to charge any additional fees which may be required, or credit any overpayment to Deposit Account No. 22-0493 . A duplicate copy of this sheet is enclosed.

d. [ ] Fees are to be charged to a credit card. **WARNING:** Information on this form may become public. **Credit card information should not be included on this form.** Provide credit card information and authorization on PTO-2038.

NOTE: Where an appropriate time limit under 37 CFR 1.494 or 1.495 has not been met, a petition to revive (37 CFR 1.137 (a) or (b)) must be filed and granted to restore the application to pending status.

SEND ALL CORRESPONDENCE TO:

Volpe and Koenig, P.C.
Suite 400, One Penn Center
1617 John F. Kennedy Boulevard
Philadelphia, PA 19103

[signature]
SIGNATURE

Randolph J. Huis
NAME

34,626
REGISTRATION NUMBER

4/PRTS

10/069473

JC19 Rec'd PCT/PTO 25 FEB 2002

Express Mail Label No. EL940598241US

PATENT

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

In the **PATENT APPLICATION** of:		
	Hauser et al.	Our File: SMB-PT042
PCT Appln. No.:	PCT/EP00/06727	(PC 00 396 B US)
Application No.:	Not Yet Known	Date: February 25, 2002
Filed:	Not Yet Known	
For: MEMBRANE PUMP		
Group:	Not Yet Known	
Examiner:	Not Yet Known	

PRELIMINARY AMENDMENT

Box PCT
Commissioner for Patents
Washington, D.C. 20231

Sir:

Prior to examination, please amend the present application as noted below.

IN THE CLAIMS

Please cancel claims 2-12, without prejudice, of the German language application.

REMARKS

Claims 2-12 of the German language specification are being cancelled in order to eliminate the improper multiple dependencies. After the application has been translated, Applicants will reintroduce the claims as annexed to the International Preliminary Examination Report.

Respectfully submitted,

Hauser et al.

By [signature]

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RJH/srs

SMB-PT042
(PC 00 396 BUS)

TRANSLATION OF INTERNATIONAL APPLICATION PCT/EP00/06727

[0001] Membrane Pump

[0002] BACKGROUND

[0003] The invention concerns a membrane pump with an operating membrane delimiting a conveying space with a supplemental membrane arranged on the side of the operating membrane facing away from the conveying space, with a membrane interspace provided between the operating membrane and the supplemental membrane as well as with a pump drive for oscillating movement of the operating and supplemental membranes in the same direction, whereby the membrane interspace is associated with at least one suction channel for relieving the pressure of the membrane interspace.

[0004] In configuring the membrane of a membrane pump, one endeavors to reach an optimum between rigidity and elasticity. While a high elasticity of the membrane is necessary to keep membrane tensions as low as possible, in contrast, at the same time a high rigidity is to be sought so that the membrane does not buckle under the differential pressure load between the membrane upper side and underside, and thus diminishes the drawing space volume and in the opposite case enlarges the dead space volume.

[0005] The diminution of the drawing space volume in connection with membrane vacuum pumps takes place especially in the deeper vacuum region. In this area, great

pressure differences between membrane lower and upper side arise. While on the membrane lower side, as a rule atmospheric pressure acts upon the membrane underside, the respective evacuation pressure acts on the upper side of the membrane, whereby the maximal pressure differential results from atmospheric pressure minus the ultimate pressure on the membrane.

[0006] With the usual membranes of traditional membrane pumps, especially if these membrane pumps operate in the range of the ultimate pressure and large pressure differentials act upon the membranes, it can be stated that the lateral elastic zone of the flexible membrane is buckled by the atmospheric pressure in the direction toward the conveying space. This "buckling" of the membrane leads to the drawing space volume being decisively diminished, which has negative effects on the suction capacity of the membrane pump.

[0007] This change in shape is especially marked with two and multiple stage membrane pumps with low ultimate pressures. With these pumps, the lower vacuum stage is most strongly affected since here the greatest pressure differentials arise.

[0008] In order to attain an optimum between the desired elasticity and the necessary rigidity of the membrane, in the past, one again and again found more or less good compromise solutions, whereby frequently a good suction capacity could be reached only by allowing for higher membrane tensions.

[0009] From DE 40 26 670 A1, a membrane pump is already known, the intake side

of which is connected through a connecting line with the crank space of this membrane pump. In order to be able at least to diminish or even to eliminate the pressure differentials on both sides of the operating membrane and not to expose the operating membrane to additional differential pressure-conditioned stresses, the crank space of this previously known membrane pump stands in connection with its suction side.

[0010] The membrane pump previously known from DE 40 26 670 A1 has, however, not been able to succeed in practice because the transmission of the drive forces to the crankshaft situated in the crank space and the connection of this crank space with the suction side of the pump presupposes an additional shaft sealing. Such a shaft sealing is nonetheless associated with further friction losses, higher wear and tear and additional performance requirements. A vacuum in the crank space can in addition lead to an outgassing of the bearing grease in the connecting rod bearing, so that the ball bearing possibly runs dry. Since the bearing lubricant in the crank space can extend into the conveying flow through the connecting line, there exists the danger that the conveying medium will become contaminated.

[0011] A multiple stage pump apparatus with a turbo molecular pump is already known from DE 43 20 963 C2 which is connected in series after a two stage rotary pump constructed as a hybrid pump in the path of flow. This hybrid pump has a reciprocating piston pump on the medium entry side after which a membrane pump is connected in series

for discharging the conveying medium. The cylinder space of the pistons is closed off from the crank space by means of a sealing membrane. Thereby the interspace provided between the piston on the one hand and the sealing membrane on the other are connected with a drain which opens in the conveying flow direction in front of a suction valve of the cylinder pump.

[0012] Since this previously known reciprocating piston pump has a piston, the problems arising with an elastic membrane in connection with pressure differential stresses do not appear with this previously known pump. Rather, with this previously known reciprocating piston pump, the interspace between the piston or its associated gasket on the one hand and the sealing membrane on the other (namely when starting this previously known pump apparatus) can be immediately evacuated to the extent that an unwished overflow from the cylinder space of the reciprocating piston pump into the interspace is absent or is largely avoided, and the entire pump apparatus is therefore ready for operation more rapidly during start up.

[0013] From DE 43 28 559 C2, a membrane pump of the type mentioned at the beginning is already known which has an operating membrane, a supplemental membrane as well as a membrane interspace provided between the operating membrane and the supplemental membrane. A drain channel opens into this membrane interspace with the aid of which it is possible to bring the membrane interspace to a lower pressure before the drain channel is closed again.

[0014] There therefore exists the object of creating a membrane pump of the type mentioned at the beginning that is manufacturable with little expense and which is distinguished, even with a high elasticity of the operating membrane, by a high suction volume, and in connection with which undesired impurities of the conveying medium are avoided as far as possible.

[0015] Accomplishing this object in accordance with the invention is accomplished with a membrane pump of the type mentioned at the beginning, especially in that the membrane interspace is pneumatically joined through at least one drain channel with the suction side of the membrane pump.

[0016] With the membrane pump of the invention, the membrane interspace is pneumatically joined at least through one drain channel with the suction side of the membrane pump. Consequently, the membrane interspace is continuously evacuated such that, on the upper side of the operating membrane and on the underside of the operating membrane, the same pressures constantly prevail during the suction phase. Since in this phase consequently no pressure differential is operating between the membrane upper side and underside of the operating membrane, the operating membrane cannot buckle in the direction of the conveying space, and an undesired diminution of the drawing space is avoided. Through the larger drawing space volume, the suction capacity in the intake phase is increased. This has an especially positive action in pressure ranges or suction capacity

ranges which lie in the vicinity of the end pressure. The pressure differentials only act upon the supplemental membrane where they can have no negative influence upon the suction capacity of the membrane pump.

[0017] Since no differential pressure acts upon the operating membrane of the membrane pump of the invention, this operating membrane can be configured highly elastically without having to fear the mentioned "buckling" of this membrane. Through the more elastic layout of the operating membrane, membrane tensions decrease significantly which once again brings a clear increase in membrane life. Moreover, the shear stress arising in connection with the churning work of operating membrane can be reduced, the effectiveness of the pump can be improved, and a delay in discharge caused by buckling of the membrane is avoided.

[0018] With the aid of a more elastic operating membrane, the membrane stroke of the membrane pump of the invention can also be increased. Since no atmospheric pressure is acting on the membrane under side of the operating membrane and the operating membrane therefore no longer strikes noisily on the conveying space in the pump head, noise development in connection with the membrane pump of the invention is considerably reduced, which assumes significance especially in such pumps that are to be used as suction pumps in medical technology.

[0019] Since with the membrane pump of the invention, only the membrane interspace

provided between operating membrane and supplemental membrane, and not the crank space as well, is joined with the suction side of the pump, and since with the membrane pump of the invention the crank space can also continue, for example, to remain under atmospheric pressure, a special shaft sealing in the region of the crankshaft is not necessary. In addition, a penetration of bearing grease into the conveying stream is not to be expected, and undesired contamination of the conveying medium is avoided with certainty.

[0020] An especially simple embodiment in accordance with the invention provides that the membrane interspace is pneumatically joined through at least one suction channel parallel to the conveying space with the pump inlet. With this embodiment, the pump on the one hand sucks through the pump inlet and on the other hand, through the suction channel, out of the membrane interspace.

[0021] A refinement in accordance with the invention in contrast provides that the pump inlet is pneumatically joined through the membrane interspace and the suction channel with the conveying space. With this embodiment in accordance with the invention, the intake path runs into the pump interior from the pump inlet through the membrane interspace, the at least one suction channel and the inlet valve into the conveying space.

[0022] Here a further embodiment in accordance with the invention of independent significance worthy of protection is provided in that, in the membrane interspace, at least one intake filter and/or noise damping element is provided. Such a membrane pump in

connection with which the intake filter and/or noise damping element is arranged in the membrane interspace can be configured especially compactly.

[0023] In order additionally to counteract an undesired fluttering of the membranes and a development of noise, it is advantageous if the intake filter and/or noise damping element is manufactured of an elastic material and is acted upon by the operating membrane on the one hand as well as on the other by the supplemental membrane.

[0024] Here an especially advantageous embodiment in accordance with the invention provides that the intake filter and/or noise damping element basically fills up the membrane interspace.

[0025] The intake filter and/or noise damping element provided in the membrane interspace is associated with a particularly low manufacturing expenditure if it is configured as an open-cell foam element arranged between the operating membrane and the supplemental membrane.

[0026] In order to counteract a buckling of the elastic operating membrane in the ejection phase if the pressure on the membrane upper side continually rises in the direction of atmospheric pressure, a preferred embodiment in accordance with the invention provides that the operating membrane is allocated an inherently stable membrane bracing which is held on a connecting rod of the pump drive, and the operating membrane is braced form-fitted on the membrane reverse side, at least in a central region.

[0027] With two stage pumps, the delivery pressure of the first stage lies significantly below atmospheric pressure, that is, in the discharge phase, the pressure on the membrane upper side of the operating membrane only rises slightly. For this reason, it is especially advantageous if the membrane pump of the invention forms the first stage of a multiple stage, especially a two stage pump or pump facility.

[0028] According to a further embodiment of the invention of independent significance worthy of protection, it is provided that the operating membrane and the supplemental membrane are joined in one piece with each other into a double membrane. Here it is appropriate if the operating membrane and the supplemental membrane are joined with each other in one piece through a central spacer, and if this spacer has on its side facing away from the conveying space an undercut fastening opening for inserting a form fitted fastening element connected with a connecting rod of the pump drive.

[0029] It is especially advantageous if the operating membrane is configured as a shaped membrane with the upper side of the conveying space sided membrane being form-fitted to the contour of the conveying space in the upper dead center of the pump specified by the pump head.

[0030] Additional features of the invention will be understood from the following description of the preferred embodiments in accordance with the invention in connection with the claims and the drawings. The individual features can be utilized singly or in

combination in connection with an embodiment in accordance with the invention.

[0031] In the drawings,

[0032] Fig. 1 shows a membrane pump with an operating membrane, a supplemental membrane as well as a membrane interspace provided between these membranes, whereby the membrane interspace is joined through a suction channel parallel to the conveying space with the pump inlet,

[0033] Fig. 2 shows a membrane pump similar to that of Fig. 1, whereby the conveying space is pneumatically joined through a suction channel and the membrane interspace with the pump inlet,

[0034] Fig. 3 shows a membrane pump, similar to that of Fig. 1, whereby the operating membrane and the supplemental membrane are joined into a double membrane,

[0035] Fig. 4 shows the membrane pump of Fig. 2, whereby an intake filter and noise damping element of open-pore foam is provided which basically fills up the membrane interspace and is acted upon bilaterally by the membranes,

[0036] Fig. 5 shows a membrane pump similar to that of Fig. 1, whereby the operating membrane is allocated a inherently stable membrane bracing which supports the operating membrane in the discharge phase,

[0037] Fig. 6 shows a membrane pump belonging to the state of the art with a flat membrane which buckles under the differential pressure stress operating during the intake

phase, and

[0038] Fig. 7 shows a membrane pump likewise belonging to the state of the art in which the molded membrane buckles in the same manner as in Fig. 6.

[0039] With the previously known membrane pumps, it is desired to attain an optimum between rigidity and elasticity. A high elasticity of the membrane is necessary so that the membrane tensions are held as low as possible. Especially in the high vacuum range, large pressure differentials between membrane upper side and membrane underside arise. While the respective evacuation process pressure weighs on the membrane upper side, as a rule, atmospheric pressure acts on the membrane underside. As is represented in Fig. 6 and 7, which depict traditional membrane pumps 106, 107 with flat membrane (cf. Fig. 6) and with molded membrane (cf. Fig. 7), the lateral, especially elastic annular zone of these operating membranes 1 is buckled by atmospheric pressure during the intake phase in the direction of the conveying space 2. Through this "buckling," the drawing space volume is diminished, and the suction capacity of these pumps 106, 107 is reduced.

[0040] The membrane pumps101, 102, 103, 104 and 105 represented in Fig. 1 to 5 in contrast also have, in addition to a highly elastic operating membrane 1 delimiting a conveying space 2, a supplemental membrane 3, whereby between the operating membrane 1 and the supplemental membrane 3 a membrane interspace 4 is provided. The membranes 1, 3 clamped fast in their outer annular zones in the pump housing 5 engage in their central

region on the connecting rod of a pump drive which moves the operating membrane 1 and the supplemental membrane 3 back and forth in the same direction between an upper dead center and a lower dead center. Here only the connecting rod head 6 of the connecting rod of the pump drive is shown.

[0041] As is clear from Fig. 1 to 5, the membrane interspace 4 provided with pumps 101, 102, 103, 104 and 105 is joined through a suction channel 7 with the suction side of these membrane pumps. For this, with the membrane pumps 101, 103 and 105 represented in Fig. 1, 3 and 5, the membrane interspace 4 is pneumatically connected through the suction channel 7 parallel to the conveying space 2 with the pump inlet 8.

[0042] With membrane pumps 102 and 104 in accordance with Fig. 2 and 4, the pump inlet 8 is in contrast pneumatically joined through the membrane interspace 4 and the suction channel 7 with conveying space 2.

[0043] Since with the membrane pumps 101, 102, 103, 104 and 105 represented here, the membrane interspace 4 is pneumatically joined through at least one suction channel 7 with the suction side of the membrane pumps, the membrane interspace 4 is continuously evacuated such that on the upper side of the operating membrane 1 and on the underside of operating membrane 1, the same pressures constantly prevail during the suction phase. Since in the intake phase consequently no pressure differential between membrane upper side and underside of the operating membrane 1 is acting, the operating membrane 1 cannot buckle in

the direction of the conveying space and an undesired diminution of the drawing space volume is avoided. Through the larger drawing space volume, the suction capacity in the intake phase can be increased. This is especially significant in pressure ranges or suction capacity ranges which lie in proximity to the ultimate pressure. The pressure differentials act only on the supplemental membrane 3 where they can have no negative influence on the suction capacity of the membrane pump 101, 102, 103, 104 or 105. Since on the operating membrane 1 of membrane pumps 101 to 105, no differential pressure weighs, this operating membrane 1 can be configured highly elastic without having to fear the already mentioned "buckling" of this membrane 1.

[0044] In Fig. 4, it is represented that, in the membrane interspace 4 of the membrane pump 104, an intake filter and noise damping element 9 is provided. This intake filter and noise damping element 9 is made of an elastic material, for example of an open cell foam, and is acted upon on the one hand by operating membrane 1 and on the other hand by supplemental membrane 3. The intake filter and noise damping element 9 (which basically fill up the membrane interspace 4) is configured annularly, whereby its annular opening 10 is penetrated by the connecting rod head 6 of the connecting rod joining membranes 1, 3 with each other. Through the intake filter and noise damping element 9 provided in the membrane interspace 4, parts are eliminated and space can be saved, and the membrane pump 104 can be configured especially compactly.

[0045] In Fig. 5, it is represented that the operating membrane 1 of the membrane pump 105 is allocated an inherently stable membrane bracing 11 which is held on the connecting rod head 6 of the connecting rod. While with single stage membrane pumps 101 to 105 in accordance with Fig. 1 to Fig. 5, the membrane interspace 4 is selectively used in the suction phase in order to enlarge the drawing space volume in the discharge phase. When the pressure on the membrane upper side continually rises in the direction of atmospheric pressure, the membrane bracing 11 is inserted which supports in a form-fitted manner the operating membrane 1 of the membrane pump 5 on the membrane reverse side, at least in a central region. In this way, the dead space volume is kept low.

[0046] With membrane pumps 101, 102, 104 and 105 in accordance with Fig. 1, 2, 4 and 5, membranes 1, 3 are clamped fast in the region of a central mounting opening 12, 13 on the connecting rod head 6 of the connecting rod. Not only the supplemental membrane 3, but also the operating membrane 1 of pumps 101, 102, 103, 104 and 105 is configured as a flat membrane.

[0047] The operating membrane 1 of the membrane pump 103 represented in Fig. 3 is in contrast constructed as a molded membrane. The operating membrane 1 is joined in one piece with the supplemental membrane 3 of membrane pump 103 through a central space 14 into a double membrane 15. As is clear from Fig. 3, the spacer 14 of double membrane 15 has, on its side facing away from the conveying space 2, an undercut fastening opening into

which a form-fitted fastening element 16 joined with the connecting rod of the pump drive is inserted. Despite the high elasticity of its operating membrane 1, the membrane pumps 101, 102, 103, 104 and 105 are distinguished by a high suction capacity without a buckling of these comparatively highly elastic operating membrane 1 in the intake phase having to be feared.

SMB-PT042
(PC 00 396 BUS)

CLAIMS

1. Membrane pump (101, 102, 103, 104 and 105) with an operating membrane (1) delimiting a conveying space (2), and a supplemental membrane (3) arranged on a side of the operating membrane (1) facing away from the conveying space (2), a membrane interspace (4) provided between operating membrane (1) and supplemental membrane (3) and a pump drive connected to the operating and the supplemental membranes (1, 3) for oscillating movement in the same direction, the membrane interspace (4) is joined with at least one suction channel (7) for pressure relief of the membrane interspace (4), characterized in that the membrane interspace (4) is pneumatically joined through the at least one suction channel (7) with a suction side of the membrane pump (101, 102, 103, 104 and 105).

2. Membrane pump (101, 103, 105) according to claim 1, characterized in that the membrane interspace (2) is pneumatically joined through the at least one suction channel (7) parallel to the conveying space (2) with the pump inlet (8).

3. Membrane pump (102, 104) according to claim 1, characterized in that the pump inlet (8) is pneumatically connected through the membrane interspace (4) and the suction channel (7) with the conveying space (2).

4. Membrane pump (101) according to claim 3, characterized in that in the membrane interspace (4), at least one intake filter and/or noise damping element (9) is provided.

5. Membrane pump according to claim 4, characterized in that the intake filter and/or noise damping element (9) is made of an elastic material and is acted upon on one hand by operating membrane 1 and on the other by the supplemental membrane (3).

6. Membrane pump according to claim 4 or 5, characterized in that the intake filter and/or noise damping element generally fills the membrane interspace (4).

7. Membrane pump according to one of claims 4 to 6, characterized in that the intake filter and/or noise damping element (9) is configured as an open cell foam element arranged between the operating membrane (1) and the supplemental membrane (3).

8. Membrane pump (105) according to one of claims 1 to 7, characterized in that the operating membrane (1) includes an inherently stable membrane bracing (11) which is held on a connecting rod of the pump drive and which provides form-fitting support at least in a cental region of the operating membrane (1) on a membrane reverse side.

9. Membrane pump according to one of claims 1 to 8, characterized in that the membrane pump forms the first stage of a multistage pump or pumping facility.

10. Membrane pump (103) according to one of claims 1 to 9, characterized in that the operating membrane (1) and the supplemental membrane (3) are joined with each other in one piece to form a double membrane (15).

11. Membrane pump (103) according to claim 10, characterized in that the operating membrane (1) and the supplemental membrane (3) are joined through a central spacer (11) with each other in one piece, and the spacer (11) has on a side facing away from the conveying space (2) an undercut fastening opening for insertion of a form-fitted fastening element (16) connected with a connecting rod of the pump drive.

12. Membrane pump according to one of claims 1 to 11, characterized in that the operating membrane (1) is configured as a molded membrane.

SMB-PT042
(PC 00 396 BUS)

ABSTRACT

A membrane pump (104) with an operating membrane (1) delimiting a conveying space (2), and a supplemental membrane (3) arranged on the side of the operating membrane (1) facing away from the conveying space (2), with a membrane interspace (4) provided between the operating membrane (1) and the supplemental membrane (3) as well as with a pump drive for oscillating movement of the operating and the supplemental membranes (1, 3) in the same direction. The membrane interspace (3) is joined with at least one suction channel (7) for relieving pressure of the membrane interspace (4). The membrane interspace (4) is pneumatically joined through the at least one suction channel (7) with the suction side of this membrane pump (104). The membrane pump of the invention (104) has a high suction capacity without the problem of buckling of the elastic operating membrane (1) in the intake phase.

PTO/PCT Rec'd 08 JUL 2002

PATENT #4.

10/069473

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

In the **PATENT APPLICATION** of:	
	Hauser et al.
PCT Appln. No.:	PCT/EP00/06727
Application No.:	10/069,473
Confirmation No.:	3369
Filed:	July 14, 2000
For:	MEMBRANE PUMP
Group:	Not Yet Known
Examiner:	Not Yet Known

Our File: SMB-PT042
(PC 00 396 B US)

Date: July 1, 2002

SECOND PRELIMINARY AMENDMENT

Commissioner for Patents
Washington, D.C. 20231

Sir:

This Second Preliminary Amendment is being filed in conjunction with the translation of the above-referenced PCT application and the translation of the Annexes to the International Preliminary Examination Report (hereinafter the "Annexes"). A Substitute Specification is also being filed concurrently herewith in which the amendments provided by the Annexes have been incorporated into the Specification. Examination is to be based on the Substitute Specification.

Based on the original Preliminary Amendment, which cancelled original German language claims 2-12 in order to avoid any issues regarding the calculation of the filing fee, new claims 13-23 (which generally correspond to original claims 2-12) are being introduced by this amendment.

Please amend the application as follows:

IN THE CLAIMS

Please add the following claims:

- - 13. Membrane vacuum pump (101, 103, 105) according to claim 1, wherein the

membrane interspace (2) is pneumatically joined through the at least one suction channel (7) parallel to the conveying space (2) with the pump inlet (8).

14. Membrane vacuum pump (102, 104) according to claim 1, wherein the pump inlet (8) is pneumatically connected through the membrane interspace (4) and the suction channel (7) with the conveying space (2).

15. Membrane vacuum pump (101) according to claim 14, wherein in the membrane interspace (4), at least one intake filter and/or noise damping element (9) is provided.

16. Membrane vacuum pump according to claim 15, wherein the intake filter and/or noise damping element (9) is made of an elastic material and is acted upon on one hand by operating membrane (1) and on the other by the supplemental membrane (3).

17. Membrane vacuum pump according to claim 15, wherein the intake filter and/or noise damping element generally fills the membrane interspace (4).

18. Membrane vacuum pump according to claim 15, wherein the intake filter and/or noise damping element (9) is configured as an open cell foam element arranged between the operating membrane (1) and the supplemental membrane (3).

19. Membrane vacuum pump (105) according to one of claim 1, wherein the operating membrane (1) includes an inherently stable membrane bracing (11) which is held on a connecting rod of the pump drive and which provides form-fitting support at least in a cental region of the operating membrane (1) on a membrane reverse side.

20. Membrane vacuum pump according to claim 1, wherein the membrane pump forms a first stage of a multistage pump or pumping facility.

21. Membrane vacuum pump (103) according to claim 1, wherein the operating

membrane (1) and the supplemental membrane (3) are joined with each other in one piece to form a double membrane (15).

22. Membrane vacuum pump (103) according to claim 21, wherein the operating membrane (1) and the supplemental membrane (3) are joined through a central spacer (11) with each other in one piece, and the spacer (11) has on a side facing away from the conveying space (2) an undercut fastening opening for insertion of a form-fitted fastening element (16) connected with a connecting rod of the pump drive.

23. Membrane vacuum pump according to claim 1, wherein the operating membrane (1) is configured as a molded membrane. - -

REMARKS

Claims 1 and 13-23 are currently pending in this application. By this amendment, claims 13-23 have been added to the application. These claims have been added to the enclosed Substitute Specification upon which examination of the present application is to be based. No new matter has been introduced into the application by the Substitute Specification, which incorporates the changes from the Annexes and claims 13-23.

Prompt examination of the above-referenced application is respectfully requested.

Respectfully submitted,

Hauser et al.

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SUBSTITUTE SPECIFICATION

[0001] Membrane Vacuum Pump

[0002] BACKGROUND

[0003] The invention concerns a membrane pump with an operating membrane delimiting a conveying space with a supplemental membrane arranged on the side of the operating membrane facing away from the conveying space, with a membrane interspace provided between the operating membrane and the supplemental membrane as well as with a pump drive for oscillating movement of the operating and supplemental membranes in the same direction, whereby the membrane interspace is associated with at least one suction channel for relieving the pressure of the membrane interspace.

[0004] In configuring the membrane of a membrane pump, one endeavors to reach an optimum between rigidity and elasticity. While a high elasticity of the membrane is necessary to keep membrane tensions as low as possible, in contrast, at the same time a high rigidity is to be sought so that the membrane does not buckle under the differential pressure load between the membrane upper side and underside, and thus diminishes the drawing space volume and in the opposite case enlarges the dead space volume.

[0005] The diminution of the drawing space volume in connection with membrane vacuum pumps takes place especially in the deeper vacuum region. In this area, great

pressure differences between membrane lower and upper side arise. While on the membrane lower side, as a rule atmospheric pressure acts upon the membrane underside, the respective evacuation pressure acts on the upper side of the membrane, whereby the maximal pressure differential results from atmospheric pressure minus the ultimate pressure on the membrane.

[0006] With the usual membranes of traditional membrane pumps, especially if these membrane pumps operate in the range of the ultimate pressure and large pressure differentials act upon the membranes, it can be stated that the lateral elastic zone of the flexible membrane is buckled by the atmospheric pressure in the direction toward the conveying space. This "buckling" of the membrane leads to the drawing space volume being decisively diminished, which has negative effects on the suction capacity of the membrane pump.

[0007] This change in shape is especially marked with two and multiple stage membrane pumps with low ultimate pressures. With these pumps, the lower vacuum stage is most strongly affected since here the greatest pressure differentials arise.

[0008] In order to attain an optimum between the desired elasticity and the necessary rigidity of the membrane, in the past, one again and again found more or less good compromise solutions, whereby frequently a good suction capacity could be reached only by allowing for higher membrane tensions.

[0009] From DE 40 26 670 A1, a membrane pump is already known, the intake side

of which is connected through a connecting line with the crank space of this membrane pump. In order to be able at least to diminish or even to eliminate the pressure differentials on both sides of the operating membrane and not to expose the operating membrane to additional differential pressure-conditioned stresses, the crank space of this previously known membrane pump stands in connection with its suction side.

[0010] The membrane pump previously known from DE 40 26 670 A1 has, however, not been able to succeed in practice because the transmission of the drive forces to the crankshaft situated in the crank space and the connection of this crank space with the suction side of the pump presupposes an additional shaft sealing. Such a shaft sealing is nonetheless associated with further friction losses, higher wear and tear and additional performance requirements. A vacuum in the crank space can in addition lead to an outgassing of the bearing grease in the connecting rod bearing, so that the ball bearing possibly runs dry. Since the bearing lubricant in the crank space can extend into the conveying flow through the connecting line, there exists the danger that the conveying medium will become contaminated.

[0011] A multiple stage pump apparatus with a turbo molecular pump is already known from DE 43 20 963 C2 which is connected in series after a two stage rotary pump constructed as a hybrid pump in the path of flow. This hybrid pump has a reciprocating piston pump on the medium entry side after which a membrane pump is connected in series

for discharging the conveying medium. The cylinder space of the pistons is closed off from the crank space by means of a sealing membrane. Thereby the interspace provided between the piston on the one hand and the sealing membrane on the other are connected with a drain which opens in the conveying flow direction in front of a suction valve of the cylinder pump.

[0012] Since this previously known reciprocating piston pump has a piston, the problems arising with an elastic membrane in connection with pressure differential stresses do not appear with this previously known pump. Rather, with this previously known reciprocating piston pump, the interspace between the piston or its associated gasket on the one hand and the sealing membrane on the other (namely when starting this previously known pump apparatus) can be immediately evacuated to the extent that an unwished overflow from the cylinder space of the reciprocating piston pump into the interspace is absent or is largely avoided, and the entire pump apparatus is therefore ready for operation more rapidly during start up.

[0013] From DE 43 28 559 C2, a membrane pump of the type mentioned at the beginning is already known which has an operating membrane, a supplemental membrane as well as a membrane interspace provided between the operating membrane and the supplemental membrane. A drain channel opens into this membrane interspace with the aid of which it is possible to bring the membrane interspace to a lower pressure before the drain

channel is closed again.

[0014] From FR-A-1 292 254, a membrane-compressor is known, that has a working membrane and a supplemental membrane, which define a membrane interspace therebetween. The known membrane-compressor includes a pressurized inlet channel that is connected to the membrane interspace. With the help of the inlet channel, a pressure is created in the membrane interspace that supports the working membrane and which lies between atmospheric pressure and the discharge pressure. In order to control the membrane interspace desired pressure and to be able to reduce the standing pressure on the pressurized side of the compressor, a nozzle is located in the inlet channel. The idea of a pressure discharge is not desired in the compressor known from FR-A- 1 292 254.

[0015] There therefore exists the object of creating a membrane pump of the type mentioned at the beginning that is manufacturable with little expense and which is distinguished, even with a high elasticity of the operating membrane, by a high suction volume, and in connection with which undesired impurities of the conveying medium are avoided as far as possible.

[0016] Accomplishing this object in accordance with the invention is accomplished with a membrane pump of the type mentioned at the beginning, especially with the characteristics of claim 1.

[0017] With the membrane pump of the invention, the membrane interspace is

pneumatically joined at least through one drain channel with the suction side of the membrane pump. Consequently, the membrane interspace is continuously evacuated such that, on the upper side of the operating membrane and on the underside of the operating membrane, the same pressures constantly prevail during the suction phase. Since in this phase consequently no pressure differential is operating between the membrane upper side and underside of the operating membrane, the operating membrane cannot buckle in the direction of the conveying space, and an undesired diminution of the drawing space is avoided. Through the larger drawing space volume, the suction capacity in the intake phase is increased. This has an especially positive action in pressure ranges or suction capacity ranges which lie in the vicinity of the end pressure. The pressure differentials only act upon the supplemental membrane where they can have no negative influence upon the suction capacity of the membrane pump.

[0018] Since no differential pressure acts upon the operating membrane of the membrane pump of the invention, this operating membrane can be configured highly elastically without having to fear the mentioned "buckling" of this membrane. Through the more elastic layout of the operating membrane, membrane tensions decrease significantly which once again brings a clear increase in membrane life. Moreover, the shear stress arising in connection with the churning work of operating membrane can be reduced, the effectiveness of the pump can be improved, and a delay in discharge caused by buckling of

the membrane is avoided.

[0019] With the aid of a more elastic operating membrane, the membrane stroke of the membrane pump of the invention can also be increased. Since no atmospheric pressure is acting on the membrane under side of the operating membrane and the operating membrane therefore no longer strikes noisily on the conveying space in the pump head, noise development in connection with the membrane pump of the invention is considerably reduced, which assumes significance especially in such pumps that are to be used as suction pumps in medical technology.

[0020] Since with the membrane pump of the invention, only the membrane interspace provided between operating membrane and supplemental membrane, and not the crank space as well, is joined with the suction side of the pump, and since with the membrane pump of the invention the crank space can also continue, for example, to remain under atmospheric pressure, a special shaft sealing in the region of the crankshaft is not necessary. In addition, a penetration of bearing grease into the conveying stream is not to be expected, and undesired contamination of the conveying medium is avoided with certainty.

[0021] An especially simple embodiment in accordance with the invention provides that the membrane interspace is pneumatically joined through at least one suction channel parallel to the conveying space with the pump inlet. With this embodiment, the pump on the

one hand sucks through the pump inlet and on the other hand, through the suction channel, out of the membrane interspace.

[0022] A refinement in accordance with the invention in contrast provides that the pump inlet is pneumatically joined through the membrane interspace and the suction channel with the conveying space. With this embodiment in accordance with the invention, the intake path runs into the pump interior from the pump inlet through the membrane interspace, the at least one suction channel and the inlet valve into the conveying space.

[0023] Here a further embodiment in accordance with the invention of independent significance worthy of protection is provided in that, in the membrane interspace, at least one intake filter and/or noise damping element is provided. Such a membrane pump in connection with which the intake filter and/or noise damping element is arranged in the membrane interspace can be configured especially compactly.

[0024] In order additionally to counteract an undesired fluttering of the membranes and a development of noise, it is advantageous if the intake filter and/or noise damping element is manufactured of an elastic material and is acted upon by the operating membrane on the one hand as well as on the other by the supplemental membrane.

[0025] Here an especially advantageous embodiment in accordance with the invention provides that the intake filter and/or noise damping element basically fills up the membrane interspace.

[0026] The intake filter and/or noise damping element provided in the membrane interspace is associated with a particularly low manufacturing expenditure if it is configured as an open-cell foam element arranged between the operating membrane and the supplemental membrane.

[0027] In order to counteract a buckling of the elastic operating membrane in the ejection phase if the pressure on the membrane upper side continually rises in the direction of atmospheric pressure, a preferred embodiment in accordance with the invention provides that the operating membrane is allocated an inherently stable membrane bracing which is held on a connecting rod of the pump drive, and the operating membrane is braced form-fitted on the membrane reverse side, at least in a central region.

[0028] With two stage pumps, the delivery pressure of the first stage lies significantly below atmospheric pressure, that is, in the discharge phase, the pressure on the membrane upper side of the operating membrane only rises slightly. For this reason, it is especially advantageous if the membrane pump of the invention forms the first stage of a multiple stage, especially a two stage pump or pump facility.

[0029] According to a further embodiment of the invention of independent significance worthy of protection, it is provided that the operating membrane and the supplemental membrane are joined in one piece with each other into a double membrane. Here it is appropriate if the operating membrane and the supplemental membrane are joined

with each other in one piece through a central spacer, and if this spacer has on its side facing away from the conveying space an undercut fastening opening for inserting a form fitted fastening element connected with a connecting rod of the pump drive.

[0030] It is especially advantageous if the operating membrane is configured as a shaped membrane with the upper side of the conveying space sided membrane being form-fitted to the contour of the conveying space in the upper dead center of the pump specified by the pump head.

[0031] Additional features of the invention will be understood from the following description of the preferred embodiments in accordance with the invention in connection with the claims and the drawings. The individual features can be utilized singly or in combination in connection with an embodiment in accordance with the invention.

[0032] In the drawings,

[0033] Fig. 1 shows a membrane pump with an operating membrane, a supplemental membrane as well as a membrane interspace provided between these membranes, whereby the membrane interspace is joined through a suction channel parallel to the conveying space with the pump inlet,

[0034] Fig. 2 shows a membrane pump similar to that of Fig. 1, whereby the conveying space is pneumatically joined through a suction channel and the membrane interspace with the pump inlet,

[0035] Fig. 3 shows a membrane pump, similar to that of Fig. 1, whereby the operating membrane and the supplemental membrane are joined into a double membrane,

[0036] Fig. 4 shows the membrane pump of Fig. 2, whereby an intake filter and noise damping element of open-pore foam is provided which basically fills up the membrane interspace and is acted upon bilaterally by the membranes,

[0037] Fig. 5 shows a membrane pump similar to that of Fig. 1, whereby the operating membrane is allocated a inherently stable membrane bracing which supports the operating membrane in the discharge phase,

[0038] Fig. 6 shows a membrane pump belonging to the state of the art with a flat membrane which buckles under the differential pressure stress operating during the intake phase, and

[0039] Fig. 7 shows a membrane pump likewise belonging to the state of the art in which the molded membrane buckles in the same manner as in Fig. 6.

[0040] With the previously known membrane pumps, it is desired to attain an optimum between rigidity and elasticity. A high elasticity of the membrane is necessary so that the membrane tensions are held as low as possible. Especially in the high vacuum range, large pressure differentials between membrane upper side and membrane underside arise. While the respective evacuation process pressure weighs on the membrane upper side, as a rule, atmospheric pressure acts on the membrane underside. As is represented in Fig.

6 and 7, which depict traditional membrane pumps 106, 107 with flat membrane (cf. Fig. 6) and with molded membrane (cf. Fig. 7), the lateral, especially elastic annular zone of these operating membranes 1 is buckled by atmospheric pressure during the intake phase in the direction of the conveying space 2. Through this "buckling," the drawing space volume is diminished, and the suction capacity of these pumps 106, 107 is reduced.

[0041] The membrane pumps101, 102, 103, 104 and 105 represented in Fig. 1 to 5 in contrast also have, in addition to a highly elastic operating membrane 1 delimiting a conveying space 2, a supplemental membrane 3, whereby between the operating membrane 1 and the supplemental membrane 3 a membrane interspace 4 is provided. The membranes 1, 3 clamped fast in their outer annular zones in the pump housing 5 engage in their central region on the connecting rod of a pump drive which moves the operating membrane 1 and the supplemental membrane 3 back and forth in the same direction between an upper dead center and a lower dead center. Here only the connecting rod head 6 of the connecting rod of the pump drive is shown.

[0042] As is clear from Fig. 1 to 5, the membrane interspace 4 provided with pumps 101, 102, 103, 104 and 105 is joined through a suction channel 7 with the suction side of these membrane pumps. For this, with the membrane pumps 101, 103 and 105 represented in Fig. 1, 3 and 5, the membrane interspace 4 is pneumatically connected through the suction channel 7 parallel to the conveying space 2 with the pump inlet 8.

[0043] With membrane pumps 102 and 104 in accordance with Fig. 2 and 4, the pump inlet 8 is in contrast pneumatically joined through the membrane interspace 4 and the suction channel 7 with conveying space 2.

[0044] Since with the membrane pumps 101, 102, 103, 104 and 105 represented here, the membrane interspace 4 is pneumatically joined through at least one suction channel 7 with the suction side of the membrane pumps, the membrane interspace 4 is continuously evacuated such that on the upper side of the operating membrane 1 and on the underside of operating membrane 1, the same pressures constantly prevail during the suction phase. Since in the intake phase consequently no pressure differential between membrane upper side and underside of the operating membrane 1is acting, the operating membrane 1 cannot buckle in the direction of the conveying space and an undesired diminution of the drawing space volume is avoided. Through the larger drawing space volume, the suction capacity in the intake phase can be increased. This is especially significant in pressure ranges or suction capacity ranges which lie in proximity to the ultimate pressure. The pressure differentials act only on the supplemental membrane 3 where they can have no negative influence on the suction capacity of the membrane pump 101, 102, 103, 104 or 105. Since on the operating membrane 1 of membrane pumps 101 to 105, no differential pressure weighs, this operating membrane 1 can be configured highly elastic without having to fear the already mentioned "buckling" of this membrane 1.

[0045] In Fig. 4, it is represented that, in the membrane interspace 4 of the membrane pump 104, an intake filter and noise damping element 9 is provided. This intake filter and noise damping element 9 is made of an elastic material, for example of an open cell foam, and is acted upon on the one hand by operating membrane 1 and on the other hand by supplemental membrane 3. The intake filter and noise damping element 9 (which basically fill up the membrane interspace 4) is configured annularly, whereby its annular opening 10 is penetrated by the connecting rod head 6 of the connecting rod joining membranes 1, 3 with each other. Through the intake filter and noise damping element 9 provided in the membrane interspace 4, parts are eliminated and space can be saved, and the membrane pump 104 can be configured especially compactly.

[0046] In Fig. 5, it is represented that the operating membrane 1 of the membrane pump 105 is allocated an inherently stable membrane bracing 11 which is held on the connecting rod head 6 of the connecting rod. While with single stage membrane pumps 101 to 105 in accordance with Fig. 1 to Fig. 5, the membrane interspace 4 is selectively used in the suction phase in order to enlarge the drawing space volume in the discharge phase. When the pressure on the membrane upper side continually rises in the direction of atmospheric pressure, the membrane bracing 11 is inserted which supports in a form-fitted manner the operating membrane 1 of the membrane pump 5 on the membrane reverse side, at least in a central region. In this way, the dead space volume is kept low.

[0047] With membrane pumps 101, 102, 104 and 105 in accordance with Fig. 1, 2, 4 and 5, membranes 1, 3 are clamped fast in the region of a central mounting opening 12, 13 on the connecting rod head 6 of the connecting rod. Not only the supplemental membrane 3, but also the operating membrane 1 of pumps 101, 102, 103, 104 and 105 is configured as a flat membrane.

[0048] The operating membrane 1 of the membrane pump 103 represented in Fig. 3 is in contrast constructed as a molded membrane. The operating membrane 1 is joined in one piece with the supplemental membrane 3 of membrane pump 103 through a central space 14 into a double membrane 15. As is clear from Fig. 3, the spacer 14 of double membrane 15 has, on its side facing away from the conveying space 2, an undercut fastening opening into which a form-fitted fastening element 16 joined with the connecting rod of the pump drive is inserted. Despite the high elasticity of its operating membrane 1, the membrane pumps 101, 102, 103, 104 and 105 are distinguished by a high suction capacity without a buckling of these comparatively highly elastic operating membrane 1 in the intake phase having to be feared.

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CLAIMS

1. Membrane vacuum pump (101, 102, 103, 104 and 105) with an operating membrane (1) delimiting a conveying space (2), and a supplemental membrane (3) arranged on a side of the operating membrane (1) facing away from the conveying space (2), a membrane interspace (4) provided between operating membrane (1) and supplemental membrane (3) and a pump drive connected to the operating and the supplemental membranes (1, 3) for oscillating movement in the same direction, whereby the membrane interspace (4) is connected with at least one suction channel (7) in order to evacuate and assimilate a pressure condition in the membrane interspace on one side and the conveying space (2) on the other side, and whereby the working membrane (1) is streched to the top and bottom dead center points of its oscillating movements.

13. Membrane vacuum pump (101, 103, 105) according to claim 1, wherein the membrane interspace (2) is pneumatically joined through the at least one suction channel (7) parallel to the conveying space (2) with the pump inlet (8).

14. Membrane vacuum pump (102, 104) according to claim 1, wherein the pump inlet (8) is pneumatically connected through the membrane interspace (4) and the suction channel (7) with the conveying space (2).

15. Membrane vacuum pump (101) according to claim 14, wherein in the membrane interspace (4), at least one intake filter and/or noise damping element (9) is provided.

16. Membrane vacuum pump according to claim 15, wherein the intake filter and/or noise damping element (9) is made of an elastic material and is acted upon on one hand by operating membrane (1) and on the other by the supplemental membrane (3).

17. Membrane vacuum pump according to claim 15, wherein the intake filter and/or noise damping element generally fills the membrane interspace (4).

18. Membrane vacuum pump according to claim 15, wherein the intake filter and/or noise damping element (9) is configured as an open cell foam element arranged between the operating membrane (1) and the supplemental membrane (3).

19. Membrane vacuum pump (105) according to one of claim 1, wherein the operating membrane (1) includes an inherently stable membrane bracing (11) which is held on a connecting rod of the pump drive and which provides form-fitting support at least in a cental region of the operating membrane (1) on a membrane reverse side.

20. Membrane vacuum pump according to claim 1, wherein the membrane pump forms a first stage of a multistage pump or pumping facility.

21. Membrane vacuum pump (103) according to claim 1, wherein the operating membrane (1) and the supplemental membrane (3) are joined with each other in one piece to form a double membrane (15).

22. Membrane vacuum pump (103) according to claim 21, wherein the operating membrane (1) and the supplemental membrane (3) are joined through a central spacer (11) with each other in one piece, and the spacer (11) has on a side facing away from the conveying space (2) an undercut fastening opening for insertion of a form-fitted fastening element (16) connected with a connecting rod of the pump drive.

23. Membrane vacuum pump according to claim 1, wherein the operating membrane (1) is configured as a molded membrane.

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ABSTRACT

A membrane pump (104) with an operating membrane (1) delimiting a conveying space (2), and a supplemental membrane (3) arranged on the side of the operating membrane (1) facing away from the conveying space (2), with a membrane interspace (4) provided between the operating membrane (1) and the supplemental membrane (3) as well as with a pump drive for oscillating movement of the operating and the supplemental membranes (1, 3) in the same direction. The membrane interspace (3) is joined with at least one suction channel (7) for relieving pressure of the membrane interspace (4). The membrane interspace (4) is pneumatically joined through the at least one suction channel (7) with the suction side of this membrane pump (104). The membrane pump of the invention (104) has a high suction capacity without the problem of buckling of the elastic operating membrane (1) in the intake phase.

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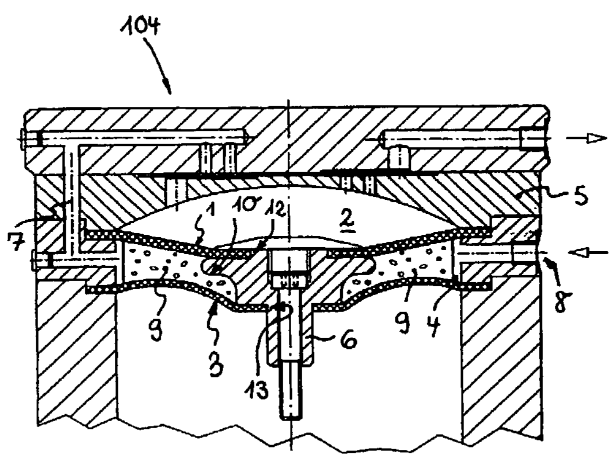
(54) Title: MEMBRANE PUMP

(54) Bezeichnung: MEMBRANPUMPE



(57) Abstract: The invention relates to a membrane pump (104) comprising a working membrane (1) that delimits a delivery chamber (2), and comprising an additional membrane (3) that is arranged on the side of the working membrane (1) facing away from the delivery chamber (2). The inventive membrane pump also comprises a membrane space (4) provided between the working membrane (1) and the additional membrane (3), and comprises a pump drive for effecting an oscillating movement of the working membrane (1) and of the additional membrane (3) in the same direction, whereby the membrane space (3) is connected to at least one suction channel (7) for relieving pressure from the membrane space (4). The inventive membrane pump (104) is characterized in that the membrane space (4) is pneumatically connected to the suction side of said membrane pump (104) via the at least one suction channel (7). The inventive membrane pump (104) is also characterized by having a high suction capacity without causing the elastic working membrane (1)to bulge during the suction phase.

(57) Zusammenfassung: Die Erfindung betrifft eine Membranpumpe (104) mit einer, einen Förderraum (2) begrenzenden Arbeitsmembran (1), mit einer auf der dem Förderraum (2) abgewandten Seite der Arbeitsmembran (1) angeordneten Zusatzmembran (3), mit einem zwischen der Arbeitsmembran

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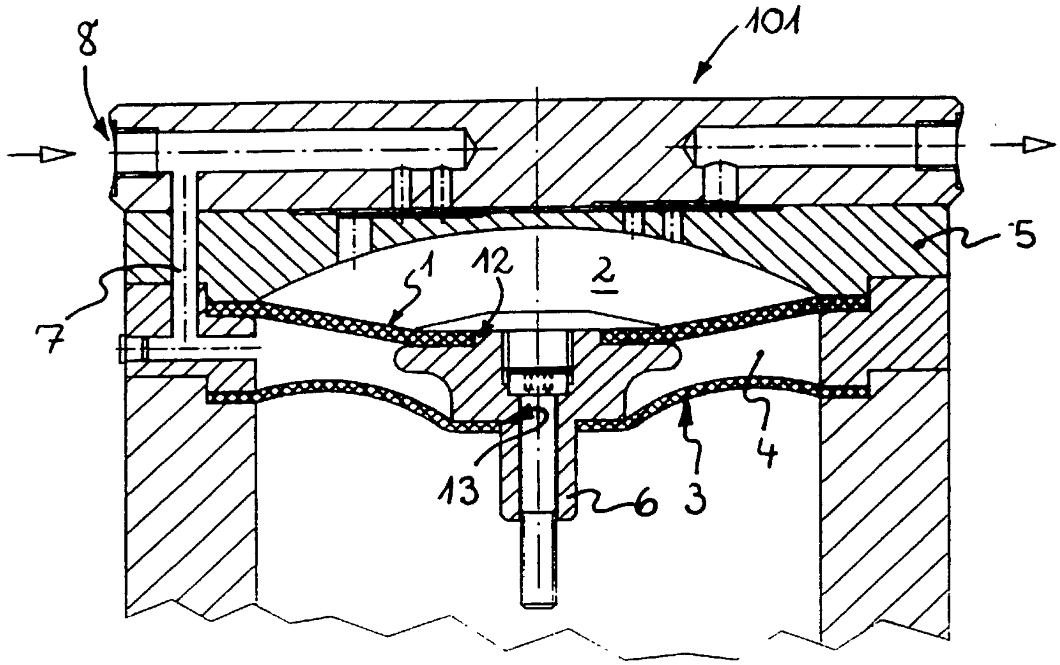

Fig. 1

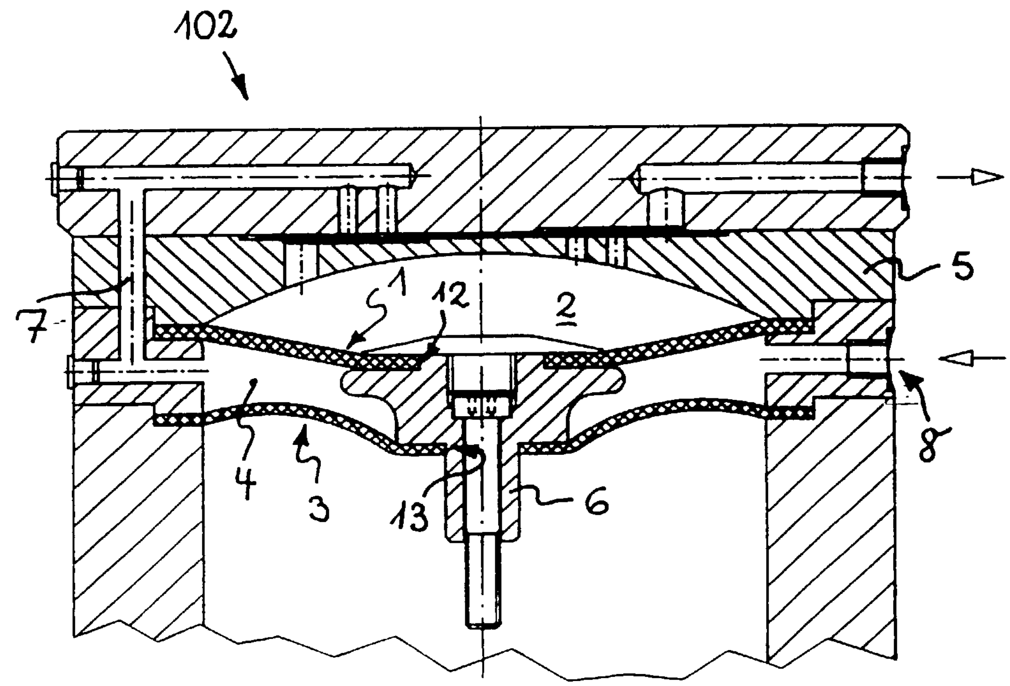

Fig. 2

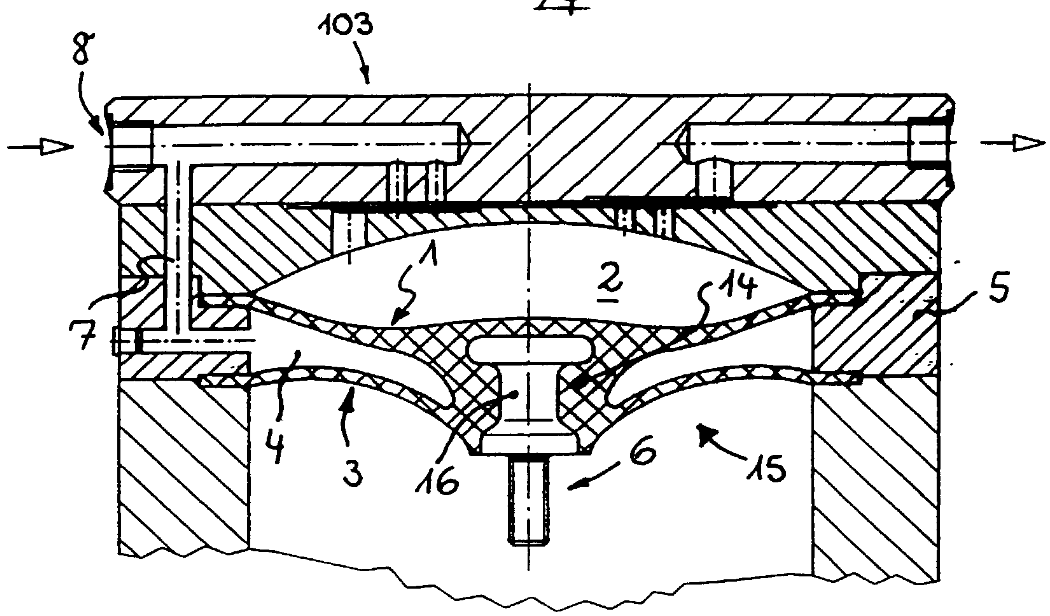

Fig. 3

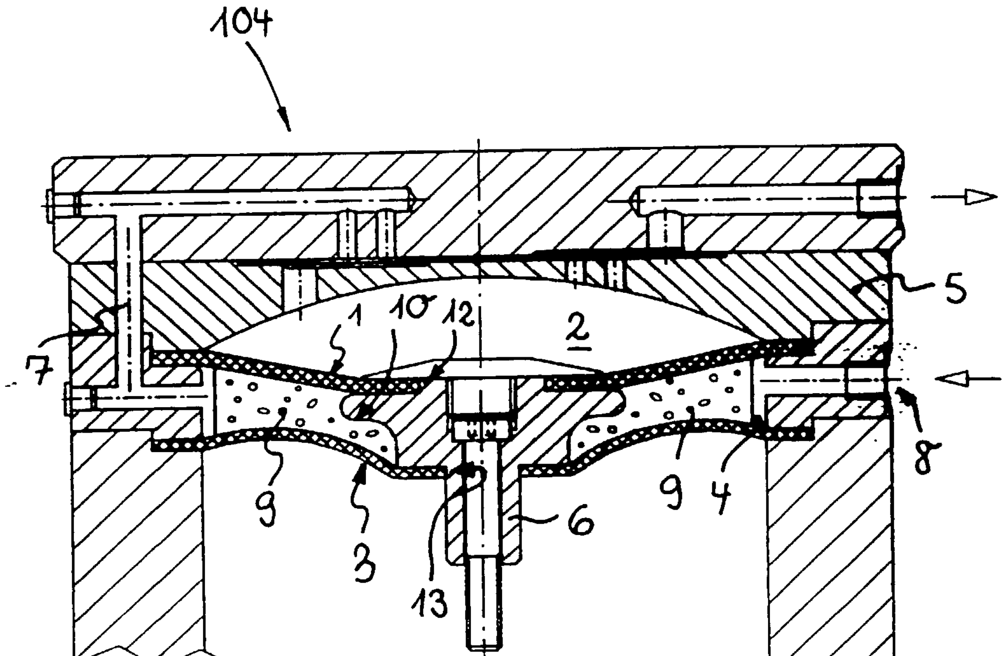

Fig. 4

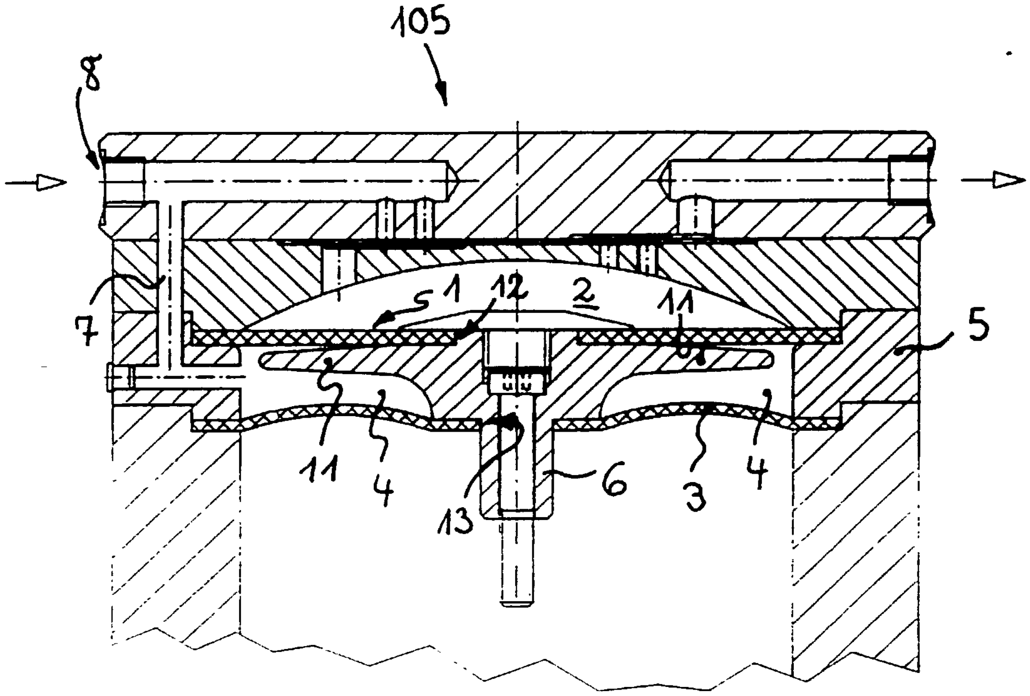

Fig. 5

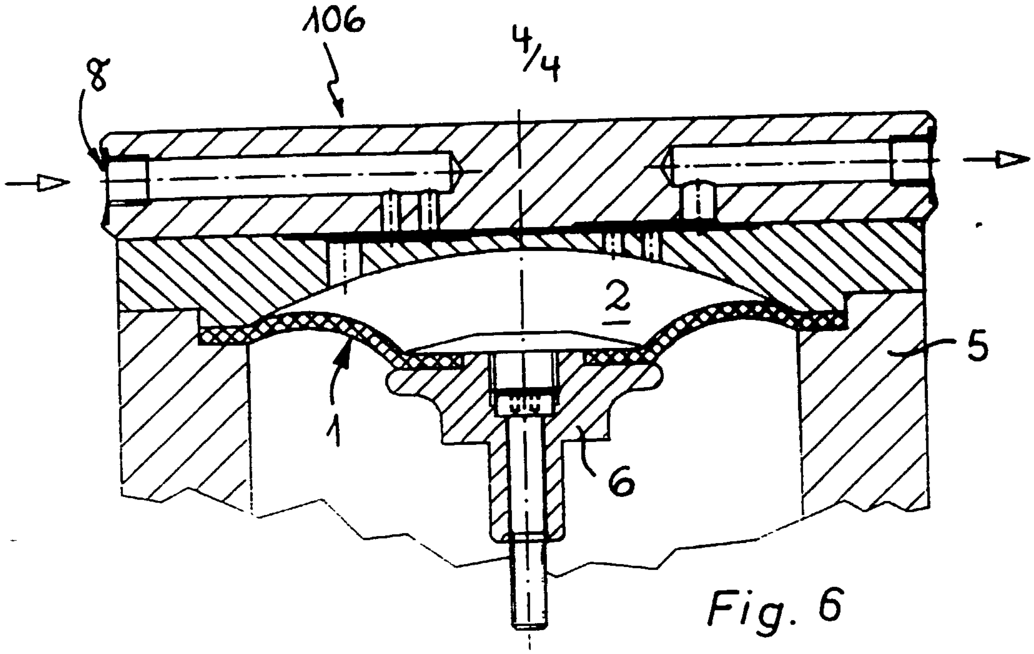

Fig. 6

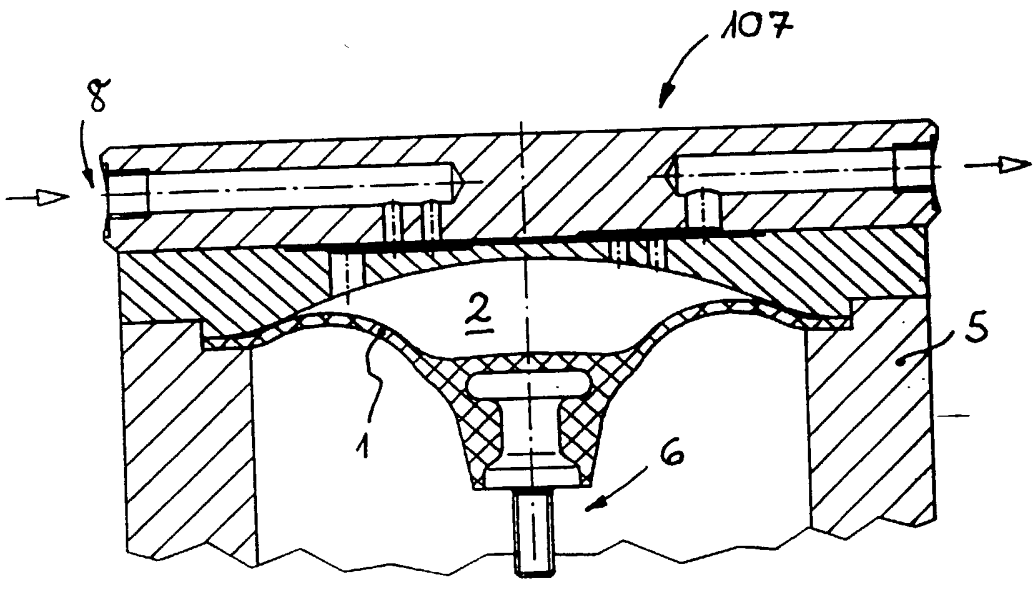

Fig. 7

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DECLARATION FOR UTILITY OR DESIGN PATENT APPLICATION (37 CFR 1.63)

☐ Declaration Submitted with Initial Filing OR ☐ Declaration Submitted after Initial Filing (surcharge (37 CFR 1.16 (e)) required)

Attorney Docket Number	SMB-PT042
First Named Inventor	Hauser et al.
COMPLETE IF KNOWN	
Application Number	Not Yet Known
Filing Date	Not Yet Known
Group Art Unit	Not Yet Known
Examiner Name	Not Yet Known

As a below named inventor, I hereby declare that:

My residence, post office address, and citizenship are as stated below next to my name.

I believe I am the original, first and sole inventor (if only one name is listed below) or an original, first and joint inventor (if plural names are listed below) of the subject matter which is claimed and for which a patent is sought on the invention entitled:

MEMBRANE PUMP

(Title of the Invention)

the specification of which

☐ is attached hereto

OR

☒ was filed on (MM/DD/YYYY) July 14, 2000 as United States Application Number or PCT International Application Number PCT/EP00/06727 and was amended on (MM/DD/YYYY) 12/03/2001 (if applicable).

I hereby state that I have reviewed and understand the contents of the above identified specification, including the claims, as amended by any amendment specifically referred to above.

I acknowledge the duty to disclose information which is material to patentability as defined in 37 CFR 1.56.

I hereby claim foreign priority benefits under 35 U.S.C. 119(a)-(d) or 365(b) of any foreign application(s) for patent or inventor's certificate, or 365(a) of any PCT international application which designated at least one country other than the United States of America, listed below and have also identified below, by checking the box, any foreign application for patent or inventor's certificate, or of any PCT international application having a filing date before that of the application on which priority is claimed.

Prior Foreign Application Number(s)	Country	Foreign Filing Date (MM/DD/YYYY)	Priority Not Claimed	Certified Copy Attached? YES	NO
199 40 498.4	Germany	08/26/1999	☐	☐	☐
			☐	☐	☐
			☐	☐	☐
			☐	☐	☐

☐ Additional foreign application numbers are listed on a supplemental priority data sheet PTO/SB/02B attached hereto:

I hereby claim the benefit under 35 U.S.C. 119(e) of any United States provisional application(s) listed below.

Application Number(s)	Filing Date (MM/DD/YYYY)	
		☐ Additional provisional application numbers are listed on a supplemental priority data sheet PTO/SB/02B attached hereto.

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DECLARATION — Utility or Design Patent Application

I hereby claim the benefit under 35 U.S.C. 120 of any United States application(s), or 365(c) of any PCT international application designating the United States of America, listed below and, insofar as the subject matter of each of the claims of this application is not disclosed in the prior United States or PCT international application in the manner provided by the first paragraph of 35 U.S.C. 112, I acknowledge the duty to disclose information which is material to patentability as defined in 37 CFR 1.56 which became available between the filing date of the prior application and the national or PCT international filing date of this application.

U.S. Parent Application or PCT Parent Number	Parent Filing Date (MM/DD/YYYY)	Parent Patent Number (if applicable)

☐ Additional U.S. or PCT international application numbers are listed on a supplemental priority data sheet PTO/SB/02B attached hereto.

As a named inventor, I hereby appoint the following registered practitioner(s) to prosecute this application and to transact all business in the Patent and Trademark Office connected therewith: ☒ Customer Number 3624 → Place Customer Number Bar Code Label here
OR
☐ Registered practitioner(s) name/registration number listed below

Name	Registration Number	Name	Registration Number
Namely, the Attorneys of Volpe and Koenig, P.C.			

☐ Additional registered practitioner(s) named on supplemental Registered Practitioner Information sheet PTO/SB/02C attached hereto.

Direct all correspondence to: ☒ Customer Number or Bar Code Label 3624 OR ☐ Correspondence address below

Name	VOLPE AND KOENIG, P.C.				
Address					
Address					
City		State		ZIP	
Country		Telephone		Fax	

I hereby declare that all statements made herein of my own knowledge are true and that all statements made on information and belief are believed to be true; and further that these statements were made with the knowledge that willful false statements and the like so made are punishable by fine or imprisonment, or both, under 18 U.S.C. 1001 and that such willful false statements may jeopardize the validity of the application or any patent issued thereon.

Name of Sole or First Inventor: ☐ A petition has been filed for this unsigned inventor

Given Name (first and middle [if any])	Family Name or Surname
Erwin	Hauser

1 – ∞

Inventor's Signature	Erwin Hauser					Date	22.02.02
Residence: City	Emmendingen-Kollmarsreute DEX	State		Country	Germany	Citizenship	German
Post Office Address	Robert-Koch-Strasse 16 25.02.02 H.						
Post Office Address							
City	Emmendingen-Kollmarsreute	State		ZIP	D-79312	Country	Germany

☒ Additional inventors are being named on the 1 supplemental Additional Inventor(s) sheet(s) PTO/SB/02A attached hereto.

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DECLARATION	ADDITIONAL INVENTOR(S) Supplemental Sheet Page 2 of 2

2-00

Name of Additional Joint Inventor, if any:		☐ A petition has been filed for this unsigned inventor					
Given Name (first and middle (if any))				Family Name or Surname			
Erich				Becker			
Inventor's Signature	E. Becker					Date	22.02.02
Residence: City	Bad Krozingen DEX	State		Country	Germany	Citizenship	German
Mailing Address	Glockishofweg 13						
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Name of Additional Joint Inventor, if any:		☐ A petition has been filed for this unsigned inventor					
Given Name (first and middle (if any))				Family Name or Surname			
Inventor's Signature						Date	
Residence: City		State		Country		Citizenship	
Mailing Address							
Mailing Address							
City		State		Zip		Country	
Name of Additional Joint Inventor, if any:		☐ A petition has been filed for this unsigned inventor					
Given Name (first and middle (if any))				Family Name or Surname			
Inventor's Signature						Date	
Residence: City		State		Country		Citizenship	
Mailing Address							
Mailing Address							
City		State		Zip		Country	